

Extensive Great Northern Snow Shed Construction

Over 14,500 Ft. of Timber and Combination Concrete and Timber Protection Built in Cascade Mountains

During the summer of 1913, the Great Northern built 14,594 lineal feet of timber and combination concrete and timber snow sheds on its main line between Scenic and Tye, Washington, on the west slope of the Cascade mountains, at an expenditure of \$1,500,000. This record is unusual, not only in the amount of snow sheds built in the short distance of nine miles, where approximately 14,000 ft. of snow sheds were already in service, but more particularly because of the amount of work of this nature completed in one short season. In this latter regard, a record was made which has seldom, if ever, been equaled in similar construction. Twenty-five million feet, B. M., of timber and 55,000 cu. yd. of concrete were placed in six months; in addition a double track tunnel 1,200 ft. long was driven at a point where it accomplished a double purpose of bettering the alinement and affording protection from snow trouble. Besides this new work, very extensive repairs and improvements were made in existing timber sheds within these same limits.

LOCAL CONDITIONS

In common with other western roads, the Great Northern has always encountered trouble with snow on the western slope of the Cascade mountains, where the snow fall is unusually heavy, and where climatic conditions are conducive to snow slides. The winter of 1912-1913 was one of unusual snow fall, and the resulting interruption of traffic was unusually severe. As a result of this experience, the extensive construction of snow sheds outlined above was decided upon, to insure against further trouble.

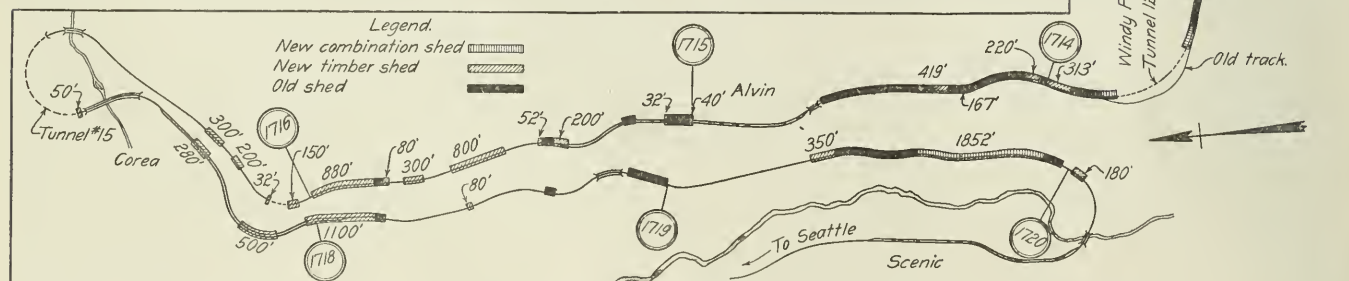
The Great Northern ascends the west slope of the Cascade mountains on a 2.2 per cent. grade for 22 miles from Skykomish to Tye, reaching an elevation of 3,093 at the latter point. From Alpine to Tye, 12 miles, the line ascends the mountain by a double loop; the first leg of the loop, between Alpine and Scenic, is on the south side of the Tye river; the other two legs, above Scenic, are on the north side of the Tye river, one line being above the other on the same side hill, so that a slide in that section, six miles in length, crosses the line twice.

COMBINATION CONCRETE AND TIMBER SHEDS

The first permanent snow sheds built by the Great Northern were constructed in 1910, and were described in the *Railway Age Gazette* of January 13, 1911. They were 1,480 ft. long and of reinforced concrete. In 1911 982 ft. additional of reinforced concrete sheds were built. While they have proven satisfactory, reinforced concrete sheds are very expensive, and to escape the high first cost, and at the same time secure permanency in all practicable respects, the permanent sheds built since 1910 have

and anchored into the rock. This back wall is 12 in. thick at the top, and 34 ft. 3 in. high above base of rail, with the front of the wall plumb and the back face battered $\frac{1}{4}$ in. per foot. It is reinforced with buttresses 2 ft. thick, spaced at intervals of 10 ft. At each buttress an anchor of concrete, heavily reinforced, extends 8 ft. into recesses blasted in solid rock. This anchor is approximately 30 in. by 42 in. in cross-section in the rock, and changes gradually to a cross-section of 2 ft. by 10 ft. at the connection with the buttress. This type of back wall contains 3.9 cu. yd. of concrete and 600 lb. of reinforcing steel per lineal foot. Owing to the comparatively few places where solid rock was encountered in the excavation, only about 900 ft. of this type of wall was built.

The type of back wall generally used was a heavy gravity wall, built without reinforcement, except for a small amount at the bracket, near the top of the rear face. This wall was built in 40 ft. sections, with complete separation between adjacent sections. A large amount of rubble, quarried directly above the wall, was incorporated in its construction, and constituted approximately 20 per cent. of the total mass of concrete. Weep holes were placed in the base at intervals of 10 ft., and in addition drain boxes with diverging wings were built on the slopes above the new sheds, to intercept the surface drainage and carry it over the sheds instead of allowing it to pass through the back fill or spread over the roof of the shed. The heavy gravity back wall contains 13 cu. yd. of concrete and 45 lb. of reinforcing steel per lineal foot.



Map Showing Location of Snow Sheds on Great Northern Line Between Scenic, Wash., and Tye

been combination concrete and timber structures, the back wall and foundations being of concrete, with timber posts and roof.

Four thousand five hundred lineal feet of combination concrete and timber sheds were built in 1913. Two types of back wall were used. Where the slope of the excavation was steep, and consisted of solid rock, a thin reinforced concrete wall was built

With the exception of the back walls, the two types of combination concrete and timber sheds are alike. They are built for double track. The posts are supported on concrete pedestals, and carry a roof of 12 in. by 12 in. timbers, laid on a slope of 1 in 5. The sheds are designed for a dead load of 900 lb. per sq. ft., in addition to 100 lb. per sq. ft. of slide action. Although

but little trouble is encountered by drifting snow in this vicinity, it piles up against the lower edge of the shed and on top, and tends to crowd into the shed from the lower side wherever the slope is relatively flat, or where there is a wide fill or "day-lighted" cut on the lower side. To protect against this trouble, the outside of all the sheds is covered with 3 in. by 12 in. planks with 3 in. spaces between them. Provision is made for removing these planks in summer. These sheds require about 700 ft. B. M., of timber and 107 lb. of hardware per lineal foot of shed.

TIMBER SHEDS

The amount of additional snow shed protection that it was desirable to build in 1913 was so great that it would have been

should be undertaken in one season, and it was all constructed for double track, on permanent alinement. The remaining 10,094 ft. of new shed was therefore built of timber.

The accompanying plans of the timber sheds indicate variations used to suit the different slopes, and different materials en-



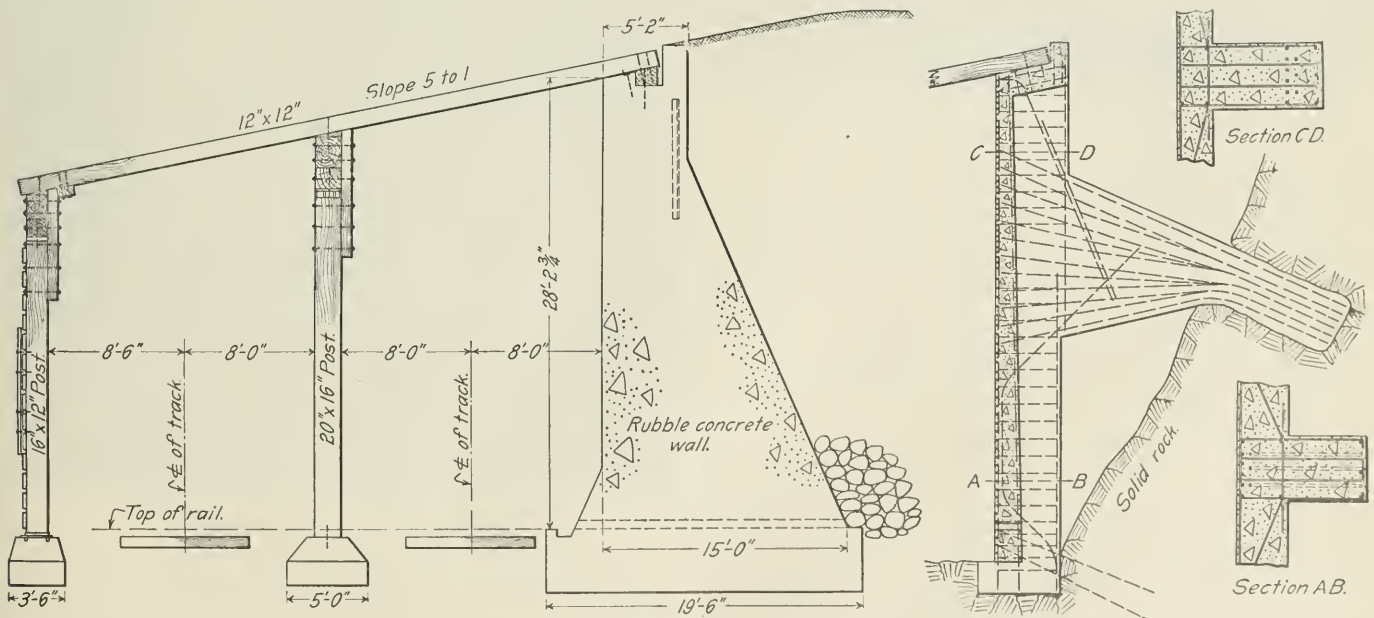
Removing Snow from Top of Old Timber Shed to be Wrecked One Mile East of Scenic on May 6



View of Loop at Scenic, Taken from Alvin

impossible to build all of the new sheds of the concrete and timber types above described. This was especially true because wherever a concrete back wall has been built it has been located in reference to a double track line, and in many places to so

countered. Where the side of the excavation was solid material or where the slope was flat enough, vertical posts were placed directly upon sills. In many places the material was too loose or the slope too steep to permit this kind of construction, and cribs were built up to conform to the slope of the bank. On steep slopes, where slides pass entirely over the shed, but do not lodge either on or against the lower side, the timber bents were spaced 8 ft. centers, and the sheds are designed for a load of 500 lb. per sq. ft. Wherever heavy slides are possible, or where the snow might lodge on the roof or against the outside,



Combination Timber and Concrete Snow Shed with Gravity and Reinforced Concrete Back Walls

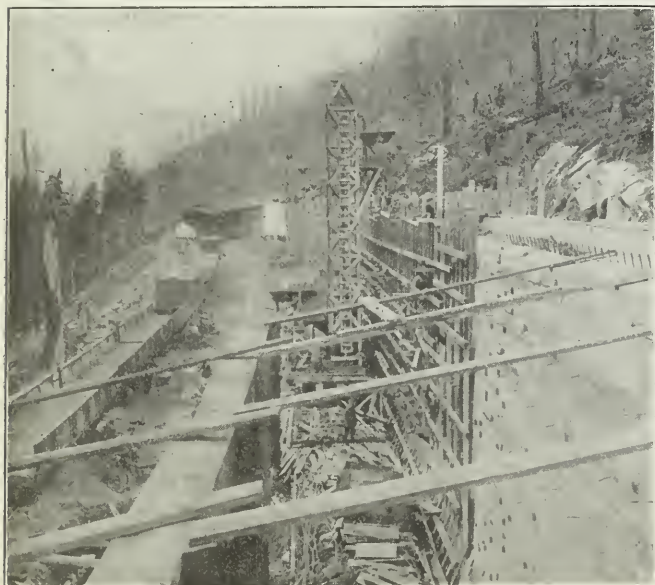
locate the concrete back wall would require a large amount of excavation, while in other cases slight changes will be made in the line when double tracking is done, so the 4,500 ft. of combination concrete and timber sheds described was considered all that

the bents were spaced 4 ft. between centers, and were designed for a load of 900 lb. per sq. ft. The sheds are all designed with a brace on the outside of each bent to resist the thrust caused by the slide action on the roof. Wherever snow might lodge

against the outside of the shed, an additional 10 ft. in width was built on the lower side, the roof of the shed being extended out over it, and its outer side being boarded with 3 in. planks from the roof down about half way on the posts, while the outside of the next row of posts (the outside posts of the regular type of shed) are similarly boarded up with 3 in. planks from the bottom to the same level. By this method, the pressure of the slide against the outside will be exerted against two rows of posts, instead of one.

CONSTRUCTION METHODS

The construction work was all handled by contract. The combination concrete and timber sheds were built by one firm, and the timber sheds by another. Of the 4,500 ft. of combination concrete and timber sheds, 1,800 ft. replaced old timber and log crib sheds, while 2,700 ft. was built where there had never been any sheds before. The replacement of the old log sheds with concrete was considerably more of a task than building entirely new sheds, as the removal of the old sheds was necessary before work could be started on the new ones. The tearing out of the old sheds was further complicated by the fact that they carried a great depth of snow, and before they could be removed the snow had to be disposed of. This work was started early in

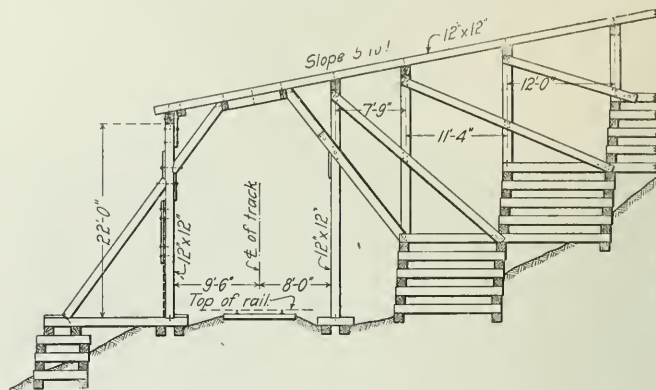


Constructing Concrete Back Wall of Combination Sheds

May, and in all 300,000 cu. yd. of snow were removed from the sheds. It was packed very hard, and much of it had to be blasted before it could be handled. Various methods of moving it were used, including a derrick, small cars loaded by hand, and hydraulicking. Some idea of the shortness of the season for carrying on so large a project may be had from the fact that two feet of snow fell as late as May 20, and snow was encountered in the work as late as July 15, while it was impracticable to plan on favorable construction weather in the fall much later than October 15.

Enough snow had been removed so that work was started on tearing out the old sheds on May 27. Enough of these were removed so that excavation for the new sheds was started on June 16, while sufficient excavation was done so that concrete work on these sheds was commenced on July 15. The three classes of work—tearing out old sheds, excavating for new ones, and placing concrete—were carried on simultaneously after that date. As soon as the excavation was far enough along to permit, additional concrete mixers were put on the work. The mixers were set on movable platforms along the front of the back wall, and were moved for every 160 ft. of wall. After being mixed, the concrete was hoisted in skips by means of a high tower, and was discharged into the forms through chutes. Six one-half

yard mixers were used in this way at one time, and handled as much as 1,000 cu. yd. per twelve-hour day, notwithstanding considerable delay which was always encountered by reason of the work being done alongside the main line, which was handling a heavy traffic besides work trains. Indeed, as soon as the excavation was far enough advanced to permit the rapid placing of concrete, the controlling feature in the progress of that work was the handling of gravel, sand and cement by the work trains.



Timber Snow Shed for Steep Slopes on Loose Material

Owing to the line being located on a steep mountain-side, there was practically no storage room for materials, so it was necessary to unload concrete material directly from the cars into the mixers. Work trains were furnished and operated by the railroad company, and a trainmaster was placed upon the work in direct charge of operation. The conditions necessitated a sufficient number, and as many as five work trains were employed at one time, handling material for both permanent and temporary sheds, and for the tunnel. Because of the steep grade, cars were not allowed to remain standing on the main line, and the engine was at all times kept on the down-hill side of the cars. With 15 carloads of cement stored at Tye and 13 at Scenic, cement was

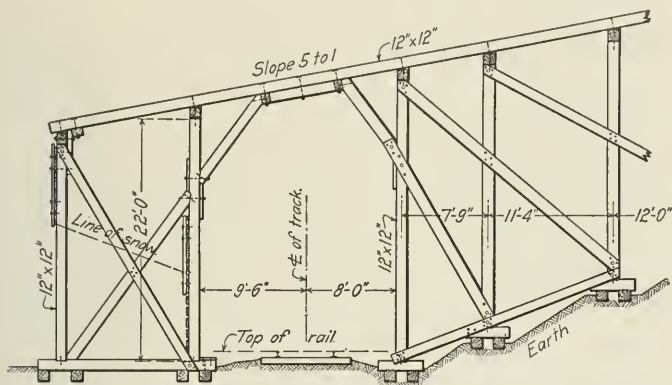


Typical Construction of Timber Sheds

shipped direct from the mill to the work. An average of 7 cars of cement and 40 cars of sand and gravel was required on the work daily.

In constructing the timber sheds all material above grade was placed with stiff leg derricks, located on the roof of the completed shed. Of the 10,000 ft. of timber shed built in 1913, 2,000 ft. was built to replace old timber and log crib sheds, while 8,000 ft. was of new construction, where there had never been any

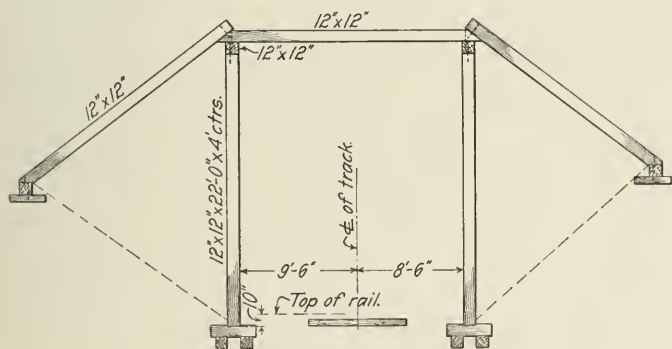
snow sheds before. While in a degree, the removal of the old timber sheds delayed and complicated the construction of the new timber sheds to replace them, as with the new combination concrete and timber sheds, the construction plant on the timber shed work was much more flexible, and could more readily be increased than that used on the combination shed work. At the height of the season 15 erecting crews were at work, each crew using one derrick; the average work of each crew while working was the erection of approximately 20,000 ft. B. M. of timber. The best day's work with one derrick in one twelve-hour shift was 56,000 ft. B. M., while the best total performance in a single day of one twelve-hour shift was 240,000 ft. B. M.



Timber Snow Sheds for Flat Slopes or Solid Supports

Before the work was started it was estimated that plant and camp provisions should be made for a force that could place 180,000 ft. B. M. daily. The work was carried on very nearly at this rate, at one time exceeding 190,000 ft. B. M. per day.

Timbers for standard sections were framed at Gold Bar, 44 miles west of Tye, but all others were framed on the ground. Boring was generally done by air with power furnished by small compressors mounted on small cars, which were set off the track, and which had a radius of operation of 300 ft. Those timbers above the track were fully bolted in position as they were placed; all others were lightly drift-bolted, and then bored in position by compressed air, and permanently bolted. Although there have been no losses by fires up to this time, a 6 in. wood stave



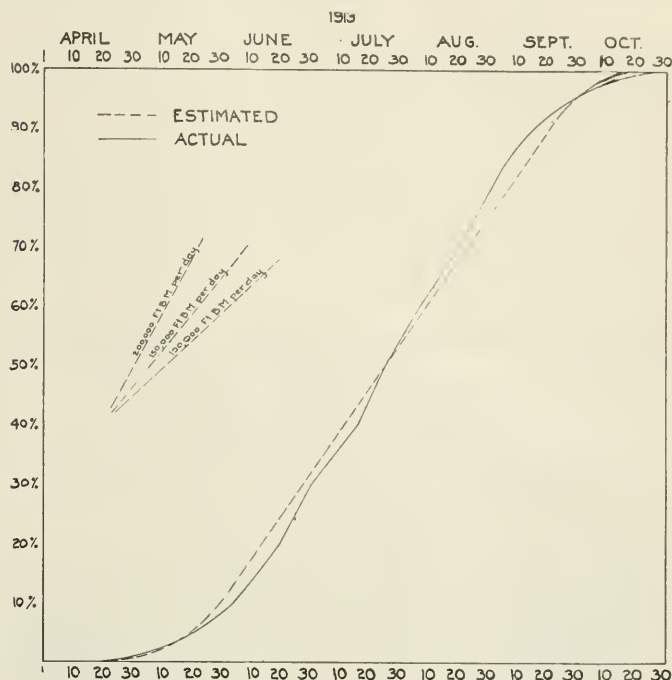
Light Timber Snow Shed at Tunnel Portals

gravity water line was built with stand pipes provided with 2½ in. hose connections every 200 ft. The congested condition of the line and the lack of storage space, of course, affected the timber sheds much as it did the combination concrete and timber sheds, and required frequent train service. After accumulating a reserve stock of 7,000,000 ft. B. M. of timber at a temporary storage yard at Gold Bar, the timber was shipped direct from the mills to the work and unloaded on the site. An average of 10 cars of lumber was required daily on the work.

WINDY POINT TUNNEL

At the east end of the loop opposite Scenic, the line turns through an angle of 90 deg., past a high bluff, known locally as

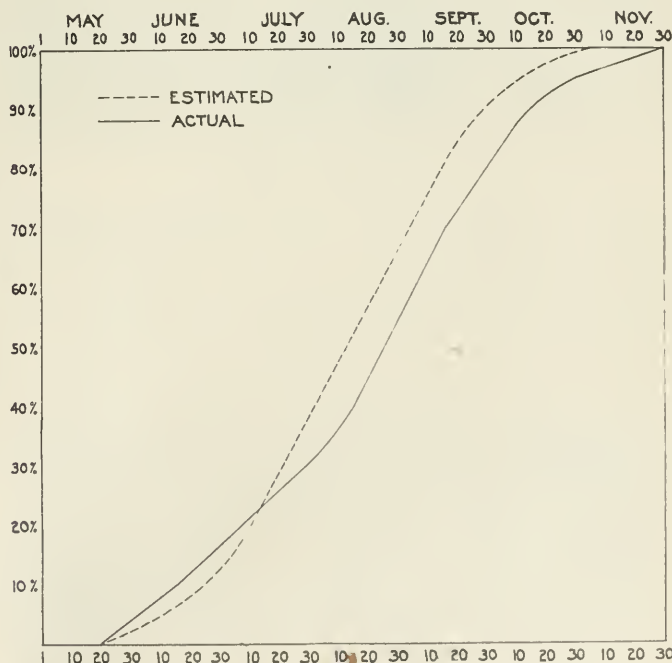
"Windy Point." To avoid the construction of sheds at this place, and also to improve the alinement somewhat, a double track tunnel, 1,200 ft. long, was constructed to replace the old line around the point. The material in this tunnel was badly broken and required timbering throughout the entire length. Being on



Curve Showing Progress on Timber Sheds

a 5 deg. curve, and built for double track, the tunnel had to be taken out very wide.

An 8 ft. by 10 ft. wall plate drift was driven on each side at the west end. Two adits were also opened in from the side of the bluff and wall plate drifts driven in each direction, so that the



Progress on Construction of Combination Shed

two drifts were driven at five different points, and ten faces in all were worked. The materials from these adits was dumped through chutes passing under the adjacent main track and wasted down the mountain side. Following these wall plate drifts

sufficient material was removed to insert timbering for the complete arch, after which the bench was removed by a steam shovel, operated with compressed air, working from the west end. No attempt was made to drive a heading from the east end as the large yardage in the east approach cut required all of the available time. This cut contained 100,000 cu. yd. of solid rock, which had to be excavated from a very high slope alongside the main line, making progress comparatively slow. Upon its completion this tunnel will be lined with concrete.

The combination concrete and timber snow sheds described above, were built by Guthrie, McDougall & Co., of Portland, Ore.; while the timber sheds and Windy Point tunnel were built by Grant Smith & Co., of Spokane, Wash. The work was handled under the direction of Ralph Budd, chief engineer, and O. S. Bowen, resident engineer. K. K. Kuney was assistant engineer, in actual charge on the ground.

WINTER RAILROADING UNDER DIFFICULTIES

As a result of the unusually heavy snow storm in the vicinity of New York on March 1-2, traffic was demoralized on nearly all the roads in that vicinity for one or more days. In common with other roads, the Ulster & Delaware Railroad suffered severely and was completely tied up for a period of two days, especially in the vicinity of Stony Clove Notch in the Catskill



Shoveling Out a Cut

Mountains. At this point, the line passes through a gorge or canyon so narrow that there is barely room for the railroad tracks and a public highway. At this point the line is built on a three per cent. grade and reaches an elevation of 2,173 ft. Although three pusher engines were attached to the snow plow in opening this cut they stuck at five different times and each time had to be shoveled out. Also, after the line was once opened, it



Snow Plow and Three Engines Stuck in a Cut

was necessary to keep the plows running back and forth for some time to keep the tracks open.

In adjacent automatic signal territory, the signals were put entirely out of commission. Although the pole line carrying the signal and telegraph wires was built entirely new last season, it was badly wrecked. About 50 per cent. of the signal arms were so matted with wet snow that they froze fast in the clear position before the line wires came down and remained in that position until signal men could arrive on the scene to chop them loose with axes. Because of the great demand for linemen, the repairs to the telegraph wires and signals were not completed until the end of the month.

AN UNUSUAL METHOD OF COLLECTING SCRAP

On January 5 to 28, inclusive, a scrap collecting train was operated over the St. Louis division on the Illinois Central in charge of the division superintendent and his entire staff, including the roadmaster, supervisors of bridges and buildings, signals, water service, etc.; trainmasters, storekeeper, master mechanic, traveling engineers, agents of the important stations, etc., making in all a party of about 50 men. The train consisted of a caboose, coach, dining car from the division wrecking outfit, and the necessary cars for the collection of the scrap material. This train moved over all the branch and main lines of the division.

In addition to the collection of scrap the entire party was organized so that each officer made a close inspection of all work under his supervision at each station. The superintendent, accompanied by the roadmaster, signal foreman and track supervisor, examined every switch and made notes of any repairs found necessary. The supervisor of bridges and buildings, with the painter foreman, inspected all buildings, stock pens, water tanks, etc., looking especially after the fire protection. The division claim clerk checked the expense bills against the freight in the freight house to determine if the agent was properly handling his accounts. The agents from the larger stations who accompanied the party checked over the passenger tariffs with the local agents at the smaller stations, and instructed them in their duties. In this way a very thorough inspection of the entire division was secured. While on this trip the quarterly staff meeting of the division officers was also held, and the men had an opportunity to examine the conditions under consideration as they went over the division.

The amount of scrap and obsolete material gathered on this train amounted to 147 car loads. The storekeeper gave credit for new material to the extent of \$581.48; second-hand material, \$7,917.76; scrap material, \$25,245.81, or a total of \$40,745.50. The cost for labor, train expense and meals on this trip amounted to \$2,203.81, leaving a net gain of \$38,541.69. In addition surplus tools valued at \$2,800 were transferred from sections where they were not needed to other sections. As an illustration of the conditions encountered, 12 bottles of ink were found at one small station, where one bottle was sufficient for nearly a year. At another point 50 non-insulated bridge rods were found at a station on insulated territory which were useless there, but serviceable elsewhere.

Entirely aside from the savings in scrap recovered, this trip was considered a success because of the opportunity it offered for the officers of each department to come in contact with the employees of that department over the entire division. It also provided an opportunity for the entire staff to discuss problems of common interest on the ground from place to place. This plan will probably be adopted on other divisions of the Illinois Central in the near future.

ICELAND TO HAVE A RAILROAD.—Hitherto the people of Iceland have had to use their excellent ponies as their means of transport. Soon, however, there will be a railway line under way between Reykjavik and the Rangarvalla district, the length being about 60 miles.